U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-258 835-T

# Study of Fabric Filters for Industrial Dust Collecting Devices

Environmental Protection Agency, Research Triangle Park, N C

1974

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PB 258 835-T
EPA-TR 146-75

# STUDY OF FABRIC FILTERS FOR INDUSTRIAL DUST COLLECTING DEVICES
[Badania tkanin filtracyjnych dla przemysłowych urzadzen odpylajacych]

By

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Published in Cement Wapno Gips
[Cement, Lime, Gypsum], No. 7, 1974

The article discusses studies on the suitability of filter fabrics used in dedusting gases in the cement industry. The equipment used in laboratory tests and on the semi-industrial scale is also described.

## Introduction

Fabric dust collectors are among the most frequently used group of dust collecting devices used to dedust gases in the bonding building materials industry. Therefore the maintenance of the dust emission from cement and limestone plants in the atmosphere within the permissible limits depends to a large extent on the efficiency of these devices.

The advantages of fabric dust collectors in comparison with other dust collecting devices used to dedust industrial gases are primarily:

-- their good dust collecting efficiency which is also obtained during the emission of very small dust particles;

Translated for NERC-Library, EPA, from the Polish by LEO KANNER ASSOCIATES, P.O. Box 5187, Redwood City, California 94063, (415) 365-3046, November 1974.

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INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

| BIBLIOGRAPHIC DATA SHEET | 1. Report No. EPA TR75-146 | 2. | 3. Recipient's Accession No. |
|---|---|---|---|
| 4. Title and Subtitle Study of fabric filters for industrial dust collecting devices | | | 5. Report Date 1974<br>6. |
| 7. Author(s) Lidia Koscianowska, Jadwiga Zareba, Jan Koscianowski | | | 8. Performing Organization Rept. No. |
| 9. Performing Organization Name and Address TRANSLATED FROM POLISH BY EPA | | | 10. Project/Task/Work Unit No.<br>11. Contract/Grant No. |
| 12. Sponsoring Organization Name and Address | Translation Service<br>Office of Administration - Library<br>Research Triangle Park, NC<br>27711 | | 13. Type of Report & Period Covered<br>14. |

15. Supplementary Notes

CEMENT WAPNO GIPS NO. 7, 1974

16. Abstracts

17. Key Words and Document Analysis. 17a. Descriptors

EPAISD

17b. Identifiers/Open-Ended Terms

OCCUPATIONAL HEALTH
AIR POLLUTION - CONTROL METHODS

17c. COSATI Field/Group 13B 68A

PRICES SUBJECT TO CHANGE

| 18. Availability Statement NTIS HAS BEEN GRANTED PERMISSION TO STORE AND DISTRIBUTE COPIES OF THIS TEXT | 19. Security Class (This Report) UNCLASSIFIED | 21. No. of Pages 25 |
|---|---|---|
| | 20. Security Class (This Page) UNCLASSIFIED | 22. Price 4.00-3.00 |

FORM NTIS-38 (10-70)

USCOMM-DC 40329-P71

-- the small effect of changes in the fine dust particles, the dust concentration and also changes in the medium on the gas dedusting efficiency;

-- the good purification of the gases attained for different chemical and mineral compositions of the precipitated dust;

-- their structural simplicity and the ease with which these devices are serviced.

The advantages of fabric dust collectors that were mentioned can be fully used in industry under operating conditions provided four basic requirements are satisfied, namely:

1. The dust collecting installation has a modern design which ensures:

-- the uniform supply of the purified gas to the surface of all bag filters;

-- the maintenance of a temperature above the dew point in the dust collector chambers;

-- good sampling of the entire amount of dust precipitated in the dust collector;

-- regular shape of the bottom part of the collector (collecting hopper) which eliminates the "wandering" when the bags are regenerated;

-- fabric economy and effective regeneration of filter bags;

-- appropriate (for the regeneration system used) tension of the filter bags obtained by using a system for the suspension of the bag which makes it possible to regulate this tension and exchange the bags quickly and easily;

-- good tightness of the chambers, valves, and the air-tight attachment of the bags to the bottom of the sieve;

-- check of the basic filter process parameters by the appropriate checking-measurement equipment;

-- reliable movement of dust collector elements.

2. The magnitude of the unit gas load on the filter surface must be selected taking into account the properties of the dust (granulation, adherence) and the properties of the filtering material (permeability, hydraulic resistance, mechanical properties, regenerating properties).

3. The filter fabric used for the bags must be properly adapted to the dust-gas medium in the given dust collector system and it must ensure a good dust collecting efficiency with the smallest possible hydraulic resistance and the smallest yearly use of filter bags.

4. The fabric dust collector must be maintained in good technical condition using appropriate preservation-repair measures.

It is known that these requirements have often not been met in the fabric filters that are currently installed in the industrial plants. This made the operation of this equipment very difficult, which, among other things, redirected investment -- in the dedusting of cement mills with large outputs -- to the installation of electrostatic filters. However, not in all dust collecting systems in cement mills which are sensitive to changes in the parameters of the dust-gas medium do the very expensive electrostatic dust collectors ensure the required degree of gas purification.

It is a reasonable expectation that this problem which pervaded the bonding building materials industry will soon be solved on the basis of the research that was carried out since 1969 in the Institute of Bonding Materials of the Building Industry in Opole.

The objective of this research is to supply the industry with a fabric dust collector with a modern design and to prepare the appropriate assortment of fabric filters which will make it possible to select these products for particular filtering conditions.

The selection of the appropriate type of fabric and of the unit gas load on the filtering surface (for definite dust-gas conditions) is a matter of first-rate importance for a fabric dust collector, since it determines the efficiency and economy of the dust collecting process as a result of the direct effect of these two factors on:

-- the magnitude of the hydraulic resistance of the dust collector;

-- the degree of gas purification;

-- the degree to which the fabric is saturated with the dust, and hence the efficiency of the regeneration system used;

-- the life of the filter bags.

The research in the Institute of Bonding Materials of the Building Industry is carried out along two lines:

1. An analysis of the assortment of the fabric filters manufactured by the textile industry and the selection of fabrics with optimum operational parameters (for the conditions in the bonding building materials industry).

2. Development of new improved designs of textile filter products satisfying regular and efficient filtration and easy use.

These tasks are not easy to realize, since they require long-term laboratory and industrial research. The filtering of industrial gases using fabrics is very complicated because of the simultaneous effect on the process of many different factors, such as the size and shape of the dust particles, the adherence of the dusts, the properties of the dust "cake" which was formed, the structural parameters of the filter fabric, the electrostatic properties, etc. Because of this, at the present time no theoretical studies are available which would make it possible to select unambiguously the filter fabric for concrete filtering conditions without laborious experimental work.

Organization and Research Methods for Textile Filter Fabrics

The filter fabrics for gas filtering manufactured by the textile industry are classified into four basic groups:

-- filter fabrics made from natural fibers: wool, cotton;

-- filter fabrics made from synthetic fibers: polyester, polyamide, polyacrylonitrile, etc.;

-- filter fabrics made from glass fibers;

-- filter fabrics from synthetic fibers mixed with wool.

In each of these groups many products are manufactured which differ from one another by their structural parameters and finish and hence also their filtering characteristics. The basic characteristics of domestic filter fabrics are given in Table 1.

The type of raw material used to manufacture the filter fabric and the refining (finish) decide basically its chemical and thermal resistance. Subsequently, on the basis of an analysis of the properties of the dust-gas medium and the properties of the produced assortment of textile filter fabrics, it is possible to make the first preliminary selection and classification of these products from the dust collecting standpoint in particular technological processes. To complete the selection it is necessary to study the changes in certain parameters of the filter fabrics that are used. These studies are carried out on the basis of the prescribed norms.

The parameters which must be studied include primarily:

-- the thermal resistance determined during the long-term and instantaneous effect of the medium;

-- resistance to wear;

## Table 1. Characteristics of domestic dust filter fabrics.

| a Rodzaj tkaniny Symbol | b Szerokość tkaniny w cm | c Numer metryczny (Nm) przędzy i rodzaj osnowa wątek | d Liczba nitek na 10 cm osnowa / wątek | e Gramatura (ciężar powierzchniowy) g/m² | f Wytrzymałość na rozciąganie kG/5 cm osnowa / wątek | g Wydłużenie % osnowa / wątek | h Wytrzymałość zmęczeniowa na zginanie (graniczna liczba zgięć) | i Odporność na ścieranie | j Przepuszczalność powietrza w $m^3/m^2/min$ przy $\Delta p$ = 20 mm $H_2O$ | k Wytrzymałość termiczna °C: l działanie długotrwałe | k Wytrzymałość termiczna °C: m działanie krótkotrwałe | n Chłonność wilgoci przy t = 20°C φ = 90% | o Odporność chemiczna na kwasy i zasady |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| p Tkaniny z włókien naturalnych<br>Wełniane: | | | | | | | | | | | | | |
| TW 1125 (WT 201) | 140 ± 3 | Wz 6, 25 Z<br>Wz 6, 25 Z | dd o. 122 ± 3<br>cc w. 80 ± 3 | 400 ± 20 | dd o. 45<br>cc w. 25 | dd o. 28<br>cc w. 40 | ff Określona dla WT 201 | | 50—65 | i i W ośrodku suchym | | | PP Niszczona przez działanie kwasu siarkowego na gorąco, dobra odporność na inne kwasy.<br>Na zasady nie odporna |
| TA 1161a (WT 202) | y 140 ± 3 wg zamówień | Wz 6, 25 Z<br>Wz 10, Z | o. 184 ± 4<br>w. 180 ± 5 | 500 ± 20 | o. 55<br>w. 45 | o. 36<br>w. 60 | dd o. 21.500<br>cc w. 17.200 | | 18—36 | 80—100 120 | | | |
| TW 1165 (WT 203) | | Wz 12, 5 Z<br>Wz 12, 5 Z | o. 190 ± 4<br>w. 170 ± 5 | 490 ± 21 | o. 42<br>w. 30 | o. 31<br>w. 60 | Określona dla WT 204<br>o. 2.0.800 | Dobra | 22—60 | w środowisku pary wodnej i podanych temp. odporność wełny znacznie maleje, duża ilość pary wodnej przy dłuższym działaniu szybko niszczy ją niezależnie od wysok. temp. | | 22 | |
| TW 1164 (WT 204) | 140 ± 3 | Wz 7 Z<br>Wz 7 Z | o. 115 ± 3<br>w. 122 ± 3 | 425 ± 20 | o. 42<br>w. 28 | o. 43<br>w. 50 | w. 20.120 | | 50—72 | | | | |
| TA 1161 (WT 205) | z rękaw po złożeniu 60 ± 1 | Wz 6, 25 Z<br>Wz 10 Z | o. 184 ± 4<br>w. 180 ± 5 | 540 ± 30 | o. 55<br>w. 45 | o. 68<br>w. 60 | | | 18—28 | | | | |
| q Bawełniane: | | | | | | | | | | | | | |
| TB 1163 (BT — 3) | z 100 ± 3 rękaw po złożeniu 85 ± 2 | Bz 54S/2 Z<br>Bz 54S/2 Z | dd o. 243 ± 5<br>cc w. 210 ± 6 | 180 ± 10 | dd o. 52<br>cc w. 45 | dd o. 19<br>cc w. 16 | gg Określona dla BT — 3<br>o. 60.600 | k k Dobra | 14—22 | 80 100 | | 14 | q q Odporne na rozcieńczone kwasy na zimno.<br>Zasady rozcieńczone na zimno nie działają szkodliwie |
| TB 1116 (BT — 15S) | | Bz 29S<br>Bz 20S | o. 190 ± 5<br>w. 180 ± 5 | 200 ± 10 | o. 50<br>w. 45 | o. 19<br>w. 15 | w. 38.000 | o. 19<br>w. 15 | 30—40 | ll W ośrodku suchym i wilgotnym | | | |
| TB 1160 (BT — 37) | 110 ± 3 | | 122/110 | 420 | o. 121<br>w. 110 | o. 25<br>w. 20 | | | 6 | | | | |
| r Bawełn.-wełniane: | | | | | | | | | | | | | |
| TWB 1164 (WBT 208) | 140 ± 3 | Bz 36/2Z<br>Wz 7Z | dd o. 220 ± 5<br>cc w. 175 ± 5 | 450 ± 25 | dd o. 48<br>cc w. 44 | dd o. 23<br>cc w. 47 | gg Określona dla WBT 210<br>o. 163.200 | k k Dobra | 14—23 | mm nn W kierunku osnowy jak bawełna | | | |
| TWB 1167 (WBT 210) | 140 ± 3 | Bz 54S/2Z<br>Wz 12, 5 Z | o. 190 ± 5<br>w. 200 ± 8 | 315 ± 25 | o. 38<br>w. 45 | o. 18<br>w. 45 | w. 604.100 | | 19—34 | W kierunku wątku jak wełna | | | |
| s Syntetyczne poliestrowe<br>Lavsanowe: | | | | | | | | | | | | | |
| TE 1163a (ET — 1) | dd szer. rękawa po złożeniu do 45 ± 1,0 powyżej 60 ± 1,5 | Elana 20z/2S<br>Elana 8, 5 Z | dd o. 208 ± 6<br>cc w. 144 ± 6 | 540 ± 30 | dd o. 260<br>cc w. 150 | dd o. 62<br>cc w. 48 | hh Określona dla ET — 3 | i i Celujące | 11—17 | j j W ośrodku suchym | | 0,3—0,6 | rr Odporne na kwasy stężone na zimno, słabe kwasy nawet w temp. wrzenia nie działają niszcząco. |
| TE 1165 (ET — 2) | | | o. 185 ± 6<br>w. 160 ± 4 | 400 ± 20 | o. 190<br>w. 180 | o. 36<br>w. 31 | | | 16—24 | 120—140 190 | | | |

[Key on following page.]

(Table continued)

Table 1 (cont'd)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TS 1160 (ET — 3)<br>TS 1164 (ET — 4) | | | dd o. 264±6<br>ee w. 154±8<br>o. 180±6<br>w. 190±8 | 510±20<br>420±21 | dd o. 270<br>ee w. 167<br>o. 220<br>w. 312 | gg w. 60<br>w. 86<br>w. 81<br>w. 36 | dd o. 560.000<br>ee w. 1.570.000 | | 14—20<br>19—12 | Działanie temp. 105°C z równoczesnym występowaniem pary wodnej powoduje obniżenie wytrzymałości na rozrywanie, lecz o mniejszym zakresie niż w wypadku tkanin wełnianych. Temp. > 105°C i duża zawartość pary wodnej powoduje hydrolizę włókna. | | Na zasady reaktywne odporne na zimno.<br>Bielone na zimno obniżają własności mechaniczne, na gorąco rozpuszczają. |
| Tortenowa:<br>P tor 8 | 140±3 | Tor 125/1<br>Tor 250/1 | dd o. 240<br>ee w. 270 | 270±14 | dd o. 200<br>ee w. 280 | dd o. 30<br>ee w. 16 | | Celujące | 12, 6 | | | |
| Syntetyczne poliamidowe Stilonowe:<br>PT — 10 | 68±1 | JpTd 210/1 | dd o. 260±12 | 270±14 | dd o. 200 | dd o. 67 | nie badano | Celujące | 8, 4 | W ośrodku suchym | | Duże odporność na działanie zasad. Niszczy się w zimnym stężonym kwasie solnym, siarkowym, octowym, mrówkowym i octowym. |
| | | JpTd 210/1 | ee w. 260±11 | | ee w. 200 | ee w. 60 | | | | | | |
| PT — 13 | 72±1 | Jak wyżej | o. 260±8<br>w. 270±6 | 275±9 | o. 191<br>w. 150 | o. 31,5<br>w. 35 | | | 22, 88 | | | |
| PT — 41 | 90±1 | JpTd 840/1<br>JpTd 840/1 | o. 230±7<br>w. 180±6 | 440±28 | o. 200<br>w. 200 | o. 70<br>w. 65 | | | 11, 57 | 60 120 | ok. 8 | |

Key:
a. Type of fabric: Symbol
b. Fabric width, cm
c. Metric number (Mn); yarns, type: warp, weft
d. No. of threads per 10 cm warp/weft
e. Grams per $m^2$ (surface weight)
f. Tensile strength, kg/5 cm; warp/weft
g. Elongation, %; warp/weft
h. Flexural fatigue strength (limiting No. of bends)
i. Wear resistance
j. Air permeability in $m^3/m^2/min$ at ...
k. Thermal strength
l. Long-range
m. Short-range
n. Moisture absorption at ...
o. Chemical resistance to acids and bases
p. Fabrics from natural fibers
q. Wool
r. Cotton
s. Cotton-wool
t. Synthetic polyester
u. Elan
v. Torlen
w. Synthetic polyamide
x. Stilon
y. According to order
z. Sleeve after folding
aa. Width of sleeve after folding up to ...
bb. Above ...
cc. Same as above
dd. Warp
ee. Weft

[Key continued on next page.]

Key to Table 1 (cont'd):

ff. Determined for ...
gg. Not investigated
hh. Good
ii. Excellent
jj. In dry medium
kk. In a water-vapor medium at the given temperatures the wool resistance decreases by a large amount, a large amount of water vapor quickly destroys it during protracted action, regardless of the temperature
ll. In dry and moist medium
mm. In the direction of the warp, as in cotton; in the direction of the weft, as in wool
nn. The joint effect of a 100°C temperature and water vapor reduces the tearing strength; however, in a smaller range than in the case of wool fabrics. A temperature greater than 100°C and a large amount of water vapor cause hydrolysis of the fiber.
oo. About 8
pp. Destroyed by the effect of sulfuric acid in hot state, good resistance to other acids. Not resistant to alkalines.
qq. Resistant to diluted acids in cold state. Diluted alkalines have no harmful effect in cold state.
rr. Resistant to concentrated acids in cold state, weak acids even at boiling temperature have no destructive effect.
ss. Resistant in cold state to diluted alkalines. Cold concentrated alkalines reduce the mechanical properties and dissolve in hot state
tt. High resistance to alkalines. Destroyed in cold concentrated hydrochloric acid, sulfuric acid, nitric acid, formic acid and acetic acid

-- flexural fatigue strength;

-- air permeability;

-- chemical resistance.

As a result of the preliminary selection, general information is obtained about the suitability of the fabric filter assortment which is analyzed in the given dust-gas conditions; however, without determining the effect of the parameters of the filtering process on its efficiency. More detailed information about the filtering process and the values of the parameters characterizing the filtering medium, namely the dust collecting efficiency and the hydraulic resistance can only be obtained given the current state of the art in the field of dust filtering through fabrics experimentally.

Generally three basic stages are used to realize the experimental work:

a) Laboratory studies;

b) Studies on the semi-industrial scale;

c) Studies on the industrial scale.

The purpose of the laboratory studies is to determine the filtering properties of fabrics for stabilized parameters of the filtering process and to use a properly selected sample of dust. A small group of fabrics suitable for the dedusting of industrial gases containing dusts whose properties are similar to the properties of the sample dusts is selected on the basis of these studies.

In the studies carried out at the Institute of Bonding Materials of the Building Industry in Opole, the "sample" industrial dusts used were the most characteristic samples from the standpoint of their physico-chemical properties, i.e.: Portland cement 250, slacket lime and coal dust. The "sample" dusts are always sampled from the same technological systems in selected industrial plants, as a result of which their physico-chemical properties and grain composition remain the same. The fineness of the "sample" dusts characterized by the mean equivalent dusts, corresponding to 50% of the fraction $d_{50}$, is represented as follows:

Portland cement 250 $d_{50}$ = 36 μm

Slacket lime $d_{50}$ = 8 μm

Coal $d_{50}$ = 30 μm

The filter fabrics are studied in a special laboratory that was built in the Institute of Bonding Materials of the Building Industry, which is shown in Fig. 1.

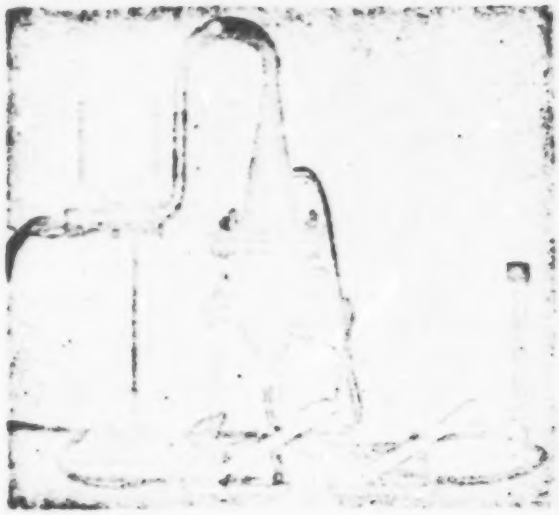

Fig. 1. Laboratory installation for study of filter fabrics.

This installation is adapted to research at climatic conditions prevailing in the building areas.

The schematic diagram (Fig. 2) shows that the basic element in the installation is the dust collector chamber consisting of three cones, with connections which measure the static pressure. The sample of the filter fabric which is studied is placed in the nest between the top and middle cone. The design of the top cone is such that the gas jet is not separated from its internal walls.

This ensures a uniform distribution of the linear velocity above the sample and a uniform dust layer on the entire 100 $cm^2$ surface of the sample. The high efficiency blotting-paper filter whose purpose is to purify the air from the dust is located between the middle and bottom cone. The sample which is studied (mounted horizontally) is dust sprayed from the top in the form of a dust-air mixture obtained from injecting the dust supplied with the aid of a feeder with a vibrator to the air jet sucked in from the

environment. The installation operates at the underpressure generated by the vacuum pump. It is equipped with a rotameter with a needle valve for the regulation and measurement of the rate of flow, with liquid-column micromanometers for the measurement of the static pressure drops on the studied samples, a paper filter and a stopwatch for the measurement of the filtering time.

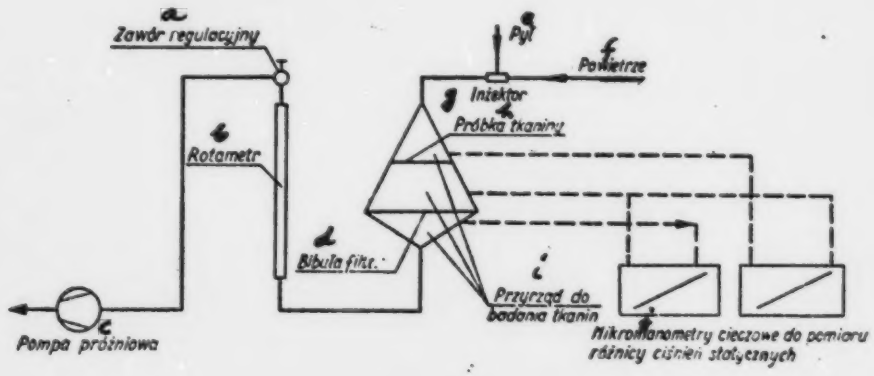


Fig. 2. Schematic diagram of laboratory installation for the study of filter fabrics.

Key: a. Control valve
b. Rotameter
c. Vacuum pump
d. Filter paper
e. Dust
f. Air
g. Injector
h. Fabric sample
i. Instrument for study of fabrics
j. Liquid-column micromanometers for measurement of static pressure differences

The laboratory installation that was described makes it possible to:

--determine the dust collecting efficiency of the filter fabric which is examined;

-- obtain the hydraulic characteristics during the flow of clean and dusty air;

-- determine the rate at which the hydraulic resistance of a given sample increases during the filtering of the dusty air under specific conditions;

-- determine the degree of dust saturation of the filter fabric during the filtering process.

The program of laboratory studies presupposes that all the quantities mentioned above will be determined for each type of filter fabric which is evaluated and the dust sample that was determined under the following conditions:

1. A unit gas load on the filtering surface:

   $q_g$ = 60, 80 and 120 $m^3/m^2/h$ for fabrics,

   $q_g$ = 100, 200 and 300 $m^3/m^2/h$ for fibers.

2. Dust coating (total amount of dust relative to clean sample):

   $H_0$ = 100, 400, 700 $g/m^2$.

3. Dust concentration in air:

   $S_p$ = 25-30 $g/m^3$.

Figure 3 shows as an example the schematic diagram for the program of laboratory studies for one type of fabric, using three different dusts. The conditions for the study were expanded by introducing two additional variables, i.e. the dust concentration and the relative humidity. The Institute has another laboratory installation which is adapted to studies of filter fabrics under variable relative humidity and temperature conditions. In this case, the surface of the studied sample is 300 $cm^2$, and it can be dust-sprayed both in a horizontal and vertical position. This installation

is designed for studies of filter products resistant to high temperatures, primarily glassy fabrics. The method used in the studies is identical on both installations that were described.

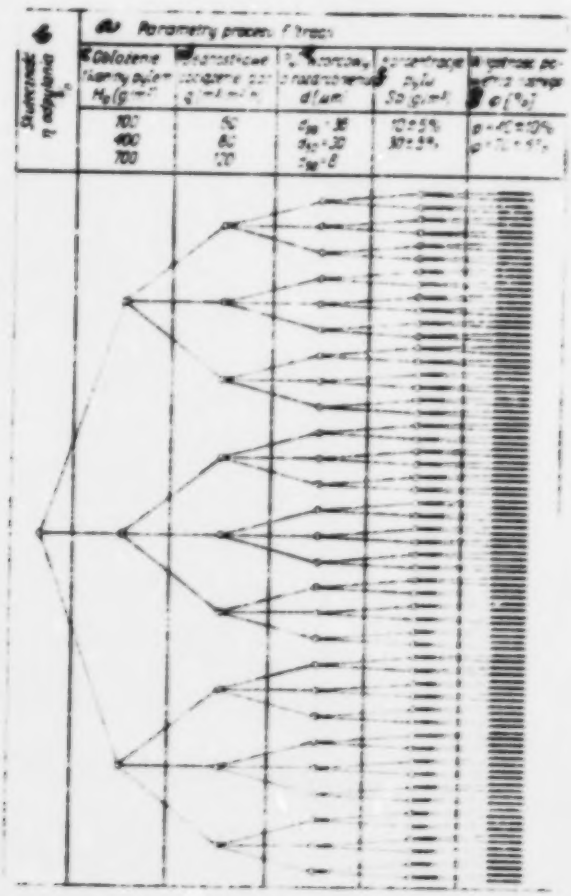

Fig. 3. Program for laboratory studies.

Key: a. Filtering process parameters
b. Dust collecting efficiency
c. Dust coating on fabric
d. Unit gas load
e. Sample dust with fineness
f. Dust concentration
g. Air humidity

The dust collecting efficiency of a sample of the product which is examined is determined from the weight, by measuring the amount of dust intercepted by the sample and the amount of dust collected by the high-efficiency filter in accordance with the relation

$$\eta = \frac{G_z}{G_c} = \frac{G_c - G_0}{G_c} = \frac{G_z}{G_z + G_0} \cdot 100\%$$

where $G_z$ is the weight of the dust intercepted by the sample, in grams; $G_0$ is the weight of the dust on the high-efficiency filter, in grams; $G_c$ is the total weight of the dust supplied above the sample, in grams.

The hydraulic characteristics of the filtering products are prepared during the flow of pure air by recording the differences in the static pressures ($kg/m^2$) on both sides of the studied sample for stabilized values of the gas load on the filtering surface ($m^3/m^2 \cdot h$).

For higher gas loads they are determined with the aid of the FF-12 type apparatus manufactured in Hungary. The hydraulic resistance of the system is recorded during the flow of the dusty air: fabric-dust or fiber-dust ($kg/m^2$) relative to the dust spraying time in minutes. Assuming for the given series of measurements a constant dust concentration, gas loads and dust coatings, we obtain the relation $\Delta p = f(\tau)$ describing the rate of change in the hydraulic resistance of the studied sample under the assumed filtering conditions.

When the entire program of studies is carried out, the hydraulic characteristics of the product coated by the assumed layer of dust can be ordered, and additional information about the changes in the dust collecting efficiency and the hydraulic resistance of the studied samples, which depends on the magnitude of the dust coating, can be obtained.

A measurement of the degree of saturation by dust of product samples that were studied under the assumed conditions provides information about their regenerative properties. The measurement is carried out every time after the sample is dust-sprayed and shaken manually in a prescribed manner, by weighing the amount of dust which remains in the sample.

Laboratory studies of fiber filter products provide a great deal of information about the filtering properties of these products and make it possible to evaluate them from the standpoint of their suitability for the collection of a particular type of dust. However, due to the laboriousness they are carried out during single-dust spraying of the samples. This fact differs from the real conditions; the location of the sample and also the reduced scale do not provide a true picture about the real values of the measured filtration process parameters. It is also not possible to determine the most efficient method for the regeneration of the filter products that are examined and the required intensity of this regeneration.

For these reasons the filter products that were selected (on the basis of the results of the laboratory studies) as suitable for dust filtering in the cement and lime-gypsum industry are studied on the semi-industrial scale, simulating industrial conditions.

The experimental installation which was built for this purpose is equipped with a single-bag filtering chamber with a normal size bag, and it is shown in Fig. 4.

The filtering chamber, which is the basic element in the experimental installation, has the shape of a cylinder. Its bottom part is equipped with the collector hopper connected hermetically with the moving dust collector.

Fig. 4. Single-bag installation for study of fabrics on semi-industrial scale.

The top part has a head whose design makes it possible to use any regeneration system. The bag in the filtering chamber has a 2.01 $m^2$ total filtering surface and a 1.82 $m^2$ active filtering surface.

The schematic diagram of the installation with the measurement and regulating system and an example of a filtering cycle are given in Fig. 5.

The dust is supplied into the cycle with the aid of a feeder with the appropriate output. The dust carrier can be either air or gas generated in the petroleum burner constructed specially for this purpose. The installation is equipped with two blowers, a circulation blower and a reverse air-flow blower, and also electric heaters which ensure dry filtering conditions in the filtering chamber.

During the filtration, the installation operates at underpressure.

The design of the pipe outlets and inlets makes it possible to regulate the gas load on the filtering surface at the values assumed by the research program and also permits the continuous operation of the blowers during the entire filtering cycle. The individual equipment units in the installation are regulated and controlled automatically.

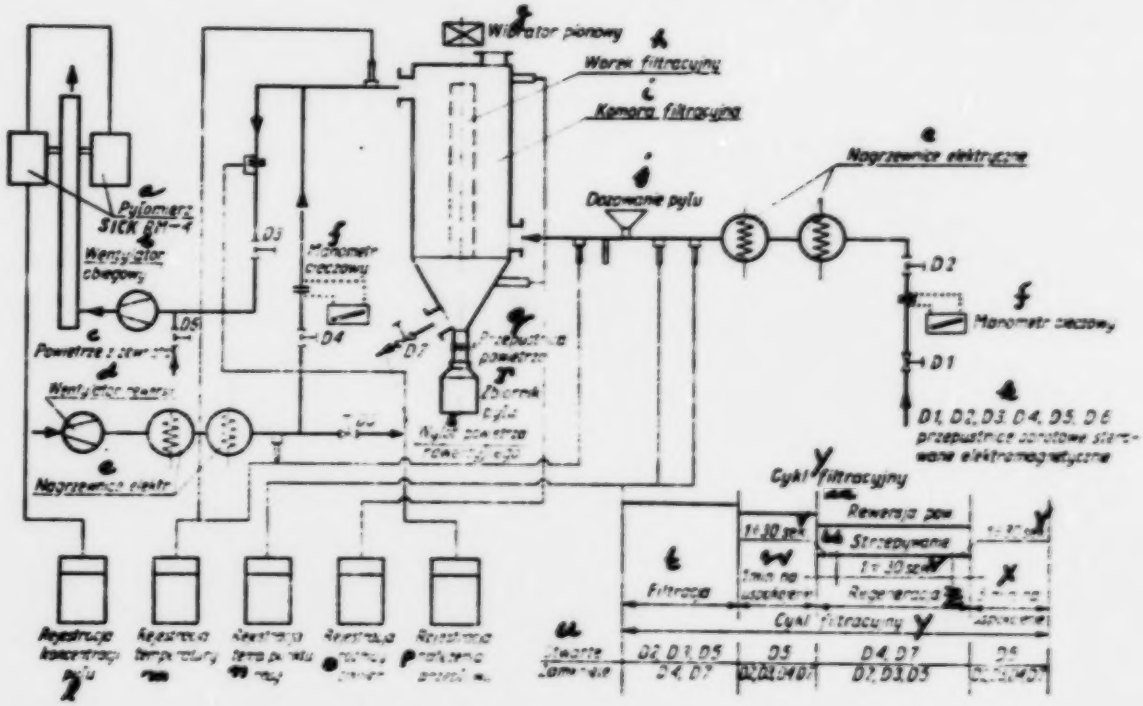


Fig. 5. Schematic diagram of single-bag installation.

Key: a. Dust meter
b. Circulation blower
c. External air
d. Reverse flow blower
e. Electric heaters
f. Liquid column pressure gauge
g. Vertical vibrator
h. Filter bag
i. Filtering chamber
j. Dust metering
k. Electromagnetically controlled valves.
l. Dust concentration recording
m. Temperature recording
n. Dew point temperature recording
o. Pressure differential recording
p. Rate of flow recording
q. Air valve
r. Dust collector

[Key continued on next page.]

Key to Fig. 5 (cont'd):

s. Reverse flow outlet
t. Filtering
u. Open/closed
v. Seconds
w. One minute for stabilization
x. Three minutes for stabilization
y. Filtering cycle
z. Regeneration
aa. Air reversal
bb. Shaking

The single-bag experimental installation is equipped with a series of measurement points which make it possible to carry out the following measurements:

-- the measurement of the amount of air directed to the dust collector in front of the area where the dust is metered;

-- the periodic measurement of the dust concentration on the conductance sector between the area where the dust is metered and the filtering chamber;

-- the continuous recording of the gas temperature before and behind the filtering chamber and the temperature of the reverse air flow;

-- the continuous measurement of the dust concentration behind the filtering chamber with the aid of the dust meter manufactured the firm SICK;

-- the measurement of the amount of reverse air;

-- the continuous recording of the amount of air behind the filtering chamber;

-- the continuous recording of the humidity of the gas brought into the filtering chamber, using the Feutron system;

-- recording of the static pressure differential in the filtering chamber;

-- recording of the duration of individual filtering cycles;

-- measurement of the air temperature in the room.

A basic assumption in the program is that the studies are carried out on a saturated bag (by repeating the filtering-regeneration cycle many times)

until its hydraulic resistance after regeneration stabilizes.

An example of the program of studies realized on a single-bag installation is given in Fig. 6. It can be seen from the example that the assumptions agree with the assumptions of the program for the laboratory studies in that the information obtained about the filtering properties of the product studied in the assumed filtering and regeneration cycle refer to a saturated structure, and hence to the stabilized state in a manner which is close to the actual state that occurs in industrial conditions. The results of the studies of the filtering process parameters simulate very closely the process in industrial dust collectors. The same installation makes it possible, in addition to realizing the research program described above whose purpose is to confirm the results of the laboratory studies, to carry out research in the optimization of the parameters of the filtering process relative to the product that is being studied and also in the optimization of the parameters of the regeneration process.

It was already mentioned in the introduction that one research trend in the Institute of Bonding Materials of the Building Industry in Opole in the selection of fiber filter products for the dedusting conditions in the bonding building materials industry is the development of new, improved designs of these products.

This work is carried out jointly with the Scientific-Research Institute of the Textile Industry, namely the Textile Institute and the Central Engineering Laboratory for Textile Products in Lodz. The goal of this research is:

-- to expand and improve the assortment of fabric filters for the dedusting of gases with temperatures up to 140°C (in collaboration with the Central Engineering Laboratory for Textile Products);

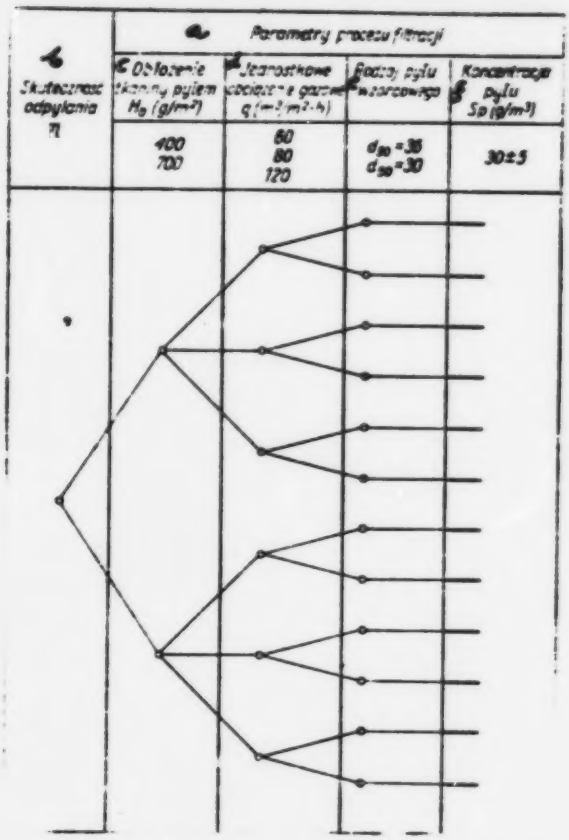


Fig. 6. Research program on semi-industrial scale.

Key: a. Parameters of filtering process
b. Dust collecting efficiency
c. Dust coating on fabric
d. Unit gas load
e. Type of sample dust
f. Dust concentration

-- studies of the possibility of dedusting hot gases with temperatures exceeding 200°C which occur in the firing of clinkers with the aid of fabric dust collectors equipped with bags manufactured from domestic glassy fabrics (in collaboration with the Textile Institute).

The research connected with the development and evaluation of the suitability of a new filter fabric design for specific dust-gas conditions takes about 2 years.

In the first year, the samples of the filter products are designed and prepared during the studies, and they are tested in the laboratory for their suitability to collect particular types of dust.

On the basis of the laboratory studies, the Institute of Bonding Materials of the Building Industry prepares an opinion about the samples that were submitted for evaluation, including conclusions pertaining to the improvement of their design. A favorable opinion about the properties of the filtering material sample is the basis for the manufacture of a prototype batch in amounts agreed on for studies on the industrial scale. The industrial studies of new fabric designs are long-range, and they are carried out until the filter bags are destroyed. On the average, the length of this period is 1 year.

The goal of the industrial studies made on new fabric designs is to obtain primarily information on:

-- the degree of gas purification and the attained dust collecting efficiency in industrial conditions;

-- the magnitude of the hydraulic resistance of the dust collector equipped with bags made from the examined filter product;

-- the life of the bags and their regeneration quality.

The studies which optimize the parameters of the filtering process are carried out on the experimental single-bag installation only after favorable results are obtained in the industrial studies.

The industrial studies of filtering products with thermal resistance up to 140°C are carried out in selected industrial installations satisfying the following conditions:

-- good technical functioning of the dust collector which ensures reliable operation of its subunits;

-- hermetic dust collecting system;

-- gas temperatures in the dust collector higher than the dewpoint temperature.

Lack of appropriate industrial installations for the dedusting of hot gases in the cement industry makes it necessary to study filtering products adapted to operations at a temperature exceeding 200°C on an experimental installation on the semi-industrial scale. The mobile experimental station which was built on the initiative of the Institute in accordance with the design of the Design Bureau of the Air-Conditioning, Ventilating and Dust Collecting Equipment plant in Katowice is shown in Fig. 7.

It consists of two chambers, each equipped with nine bags with the following dimensions: diameter, 160 mm; length, 3000 mm. The blower supplies a part of the hot gases from any point to the first chamber in which they are dedusted. The filter bags can be regenerated by mechanical shaking and reverse air-flow blowing. At the present time, a station for the study of glassy fabrics developed by the Textile Institute is being completed. The bags of these fabrics will be regenerated only by reverse air-flow. The "working" chamber is controlled automatically.

The dust is collected from both chambers with the aid of a helical conveyor which ensures continuous operation of the station.

During the studies on the industrial and semi-industrial scale, the following are carried out:

-- continuous observation of the filter bags and an analysis of the damages that occur;

Fig. 7. Mobile experimental station for dedusting of hot gases.

-- periodic measurements of the parameters of the dust-gas medium (temperature, gas humidity, dust concentration, rate of flow, static pressure);

-- periodic measurements of the hydraulic resistance of the dust collector.

Filter bag specimens are also sampled in accordance with a definite scheme and graphic schedule. The purpose is to determine the changes in the parameters of the filter products which occur during the industrial operation.

These changes are determined in the laboratory on samples cut out from each segment (between the sealing rings) of the filter bag.

The laboratory studies of the bag samples include the checking of the following parameters:

-- the mechanical tensile strength in the direction of the warp and weft;

-- the hydraulic resistance of a fabric saturated with dust;

-- dust collecting efficiency.

The results of the laboratory and industrial studies are analyzed as a function of the efficient operating time of the bags and they are referred to the initial value of the parameters of the product for the clean filtering product.

The interrelated information about the operating conditions in which the filtering product works on its mechanical properties, on its saturation by dust, the regeneration intensity and the changes occurring in the structure of the product during operation are obtained in this manner. This applies especially to information about the effects of all these factors on the dust collecting efficiency and the magnitude of the hydraulic resistance.

The research apparatus which was described and the method for the study and evaluation of textile filtering products can also be used, in addition to its practical use in the development of new types of fabrics or the selection of existing products, in basic research in dry filtering, since it can be used in many variants to carry out experiments both on the industrial and semi-industrial scale.

The apparatus that was described above is used in basic research in the field of dry filtering through textile filtering products in the

Institute of Bonding Materials of the Building Industry, whose goal is to develop a filtering model and solve problems connected with the optimization of the structure of textile filtering materials. A part of the research has been carried out jointly with the American Environmental Protection Agency in Washington.

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